19th International Command and Control
Research and Technology Symposium
"C2 Agility: Lessons Learned from Research and Operations"

Graph Analyzer Widget

Closer to Agility through Sense-Making

Topic 3: Data, Information, and Knowledge

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Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE **JUN 2014**	2. REPORT TYPE	3. DATES COVERED **00-00-2014 to 00-00-2014**
4. TITLE AND SUBTITLE **Graph Analyzer Widget Closer to Agility through Sense‐Making**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Defence R&D Canada ? Valcartier,2459 Pie‐XI North,Quebec City, QC, G3J 1X5, Canada,**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR’S ACRONYM(S)
		11. SPONSOR/MONITOR’S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES

Presented at the 18th International Command & Control Research & Technology Symposium (ICCRTS) held 16-19 June, 2014 in Alexandria, VA. U.S. Government or Federal Rights License

14. ABSTRACT

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15. SUBJECT TERMS

<table>
<tr><td colspan="3">16. SECURITY CLASSIFICATION OF:</td><td rowspan="2">17. LIMITATION OF ABSTRACT
Same as Report (SAR)</td><td rowspan="2">18. NUMBER OF PAGES
20</td><td rowspan="2">19a. NAME OF RESPONSIBLE PERSON</td></tr>
<tr><td>a. REPORT
unclassified</td><td>b. ABSTRACT
unclassified</td><td>c. THIS PAGE
unclassified</td></tr>
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

Graph Analyzer Widget
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Abstract

Social Network Analysis (SNA) is essential to understand how information flows through Social Networks and is thought to be strategic for making sense of how individuals/groups/organizations work, collaborate, co-operate, grow or influence others. Defence Research and Development Canada (DRDC) Valcartier is performing research activities on SNA. The initial research activities were focusing on SNA conducted in a counter-insurgency context and were aiming at investigating SNA methods and tools that could augment an intelligence analysis capability. In the spirit of the Visualization domain, which allows information/knowledge to be derived from the visual representation of data/information; visualization widgets were designed and grouped under the term Graph Analyzer to assist intelligence analysts in comprehending and interpreting social network (SN)-related data (automatically extracted). The Graph Analyzer Widget and other developed widgets exploit the graphical rendering of information/knowledge (e.g. graphs, diagrams, charts, etc.) which are the visual artefacts representing data, illustrating relationships and patterns among data, and also allow analysis and comparisons between graphical representations of data sets. These widgets propose interactive, explanatory and tailored visualizations to support sense-making. They combine visual representations of graph diagrams composed of nodes and links to other visual representations such as statistical results, lists of nodes, geospatial and temporal aspects or the semantic meaning of links based on a SN ontology.

1 Introduction

Would they be in Afghanistan, Haiti, Mali, Darfur, Sudan, or any region of Arabian Sea, many of the Canadian operations require to be conducted in cultures drastically different from what our military members are used to. Moreover, given the reality of asymmetric warfare, the distinction between the adversary and the local population is blurred. Consequently, there is a need to better understand such cultures but also how the locals are related to these adversaries. Operations taking place in an insurgency context have to acknowledge that insurgents mostly originate from the local population or else are strongly connected to it. This is one of the main differences between insurgents and terrorists cells. Indeed, while insurgent groups can be tightly connected to criminal or terrorist networks [Lonsdale, 2008], their motivation is different as it is initially a political one expressed through oppositions to the government in place or any instance supporting it. In this military context and from an intelligence perspective, there is a long time now that nothing is solely red, blue or white. Terminology such as pink and grey situational awareness (SA) has developed as its own type of SA [Gavriel, 2010]. As an indicator of such an interest about human related activities during

operations, the field of cultural intelligence has greatly developed along with the ones of human terrain or human geography for instance. Cultural intelligence is thus considered as a force multiplier in the contemporary operating environment [Spencer and Balasevicius, 2009], which cannot anymore be discarded.

1.1 SNA Research Activities for the Intelligence

Identifying the social and cultural aspects as a foundation to enable SA for the Intelligence purpose is one essential element expressed by many instances and defence organizations [DoD, 2008; 2011]. It also has been identified that tools and methods to take the social or cultural aspects into consideration are lacking within the intelligence function [DoD, 2011; Foster and Biggerstaff, 2006]. Social network analysis (SNA) is one of those few tools or techniques that permit to encounter the social and cultural perspectives of an operation [Ressler 2006, Knoke 2013].

While SNA tools and methods are more and more employed, it is only recently that it has been considered to enhance the intelligence capability [Wheaton and Richey, 2014; TNO, 2014; Barber et al., 2009]. The initial attempts of using SNA techniques in a military context emphasized merely the identification and neutralization of specific adversaries. The practice has evolved recognizing the limitations of such approaches. Activities converged rather toward an increased situational awareness, which includes the socio-cultural aspects by use of SNA. SNA techniques are now used to understand the structure of the local population, how the adversaries are related to it or else to other types of covert networks. Most of the time the analyses do not provide a response but more accurate questions highlighting the important elements of the situation being faced and that should be taken into consideration. It is through the understanding of all the essential components of a situation that the analyst will be able to rapidly switch from one point of pressure to another more efficient one.

It is with regard to such intelligence capability deficiency that Defence Research and Development Canada (DRDC) has engaged in research activities regarding the value of SNA for the intelligence function [Lecocq et al., 2011; Lavigne et al., 2012; Martineau and Lecocq, 2013; Lecocq et al., 2013]. Initially, the efforts were on the counter-insurgency (COIN) context in order to provide a focus for the research activities. Nevertheless, the research activities and the inspection and evaluation of SNA techniques, tools and methods have a broader scope and can be applied to different Intelligence contexts. The research along with its prototype aims at covering an entire SNA capability required by the intelligence function to increase its understanding of a specific theatre of operation or a situation being faced. Such a capability covers more stages than the sole analysis aspect as exposed in the figure below. Depicted in the Figure 1, these additional stages include: the identification of the Intelligence issues or requirements to be fulfilled (point 1); the collection of pertinent data for the subsequent required analysis along with their structuration and storage as per points 2 and 3; the adapted representation of a specific network of interest (point 4); finally it is only at that time that analyses per se can be performed as depicted in point 5. Once again, the analyses results don't stand on their own; they need to be set back into a context of significance in order for the

analyst to reach some level of sense-making, which is depicted in the same point 5 as well as point 6 where the results are set back into the context of the initial question of point 1.

Another significant characteristic of the approach is its dynamic aspect. Indeed, the collection of pertinent information and data underlying the analysis of the networks is performed on a regular basis either from structured or unstructured data sources. This implies that a same analysis performed on a network composed of social entities and relation of the same types will provide, at two different timing, distinct results to the intelligence analyst. Just like the situation will evolve its analysis will also do.

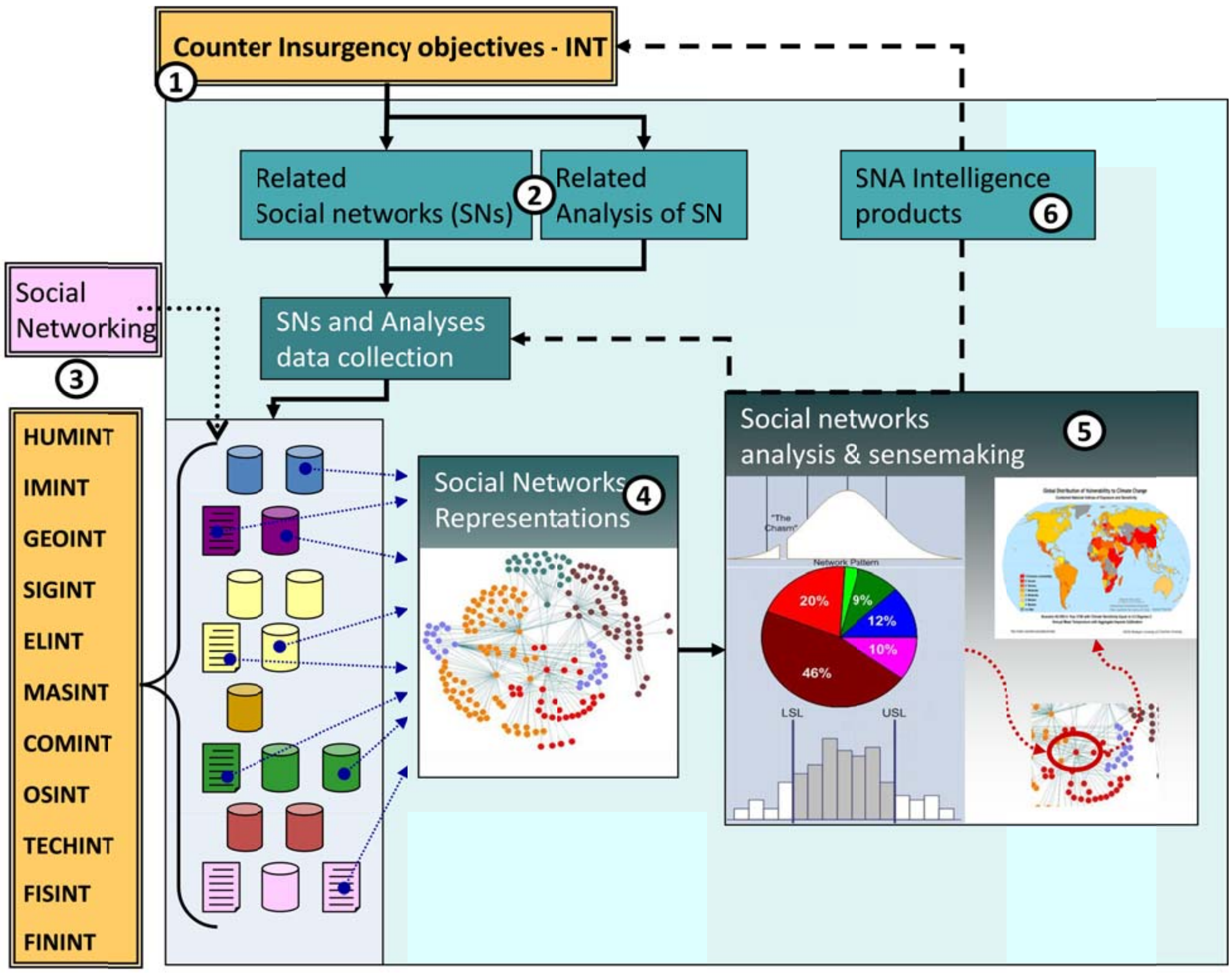

Figure 1 - Approach for the SNA proof-of-concept prototype

2 SNA Software Prototype Description

For exploration purposes, an integrative SNA prototype is being developed in the same line of thought as other authors [Semenov et al., 2011], i.e. and as explained in the previous section, it exceeds the sole analysis of SNs as pictured in Figure 1 and Figure 2. Indeed, it rather supports a SNA capability where services and functionalities cope with:

- the identification of meaningful data for the specific intelligence requirement for information;
- the automated extraction and organization of data;
- the selection of sub-networks of interest to be analysed;
- the analysis of social networks; and
- the sense-making brought to light by use of visualization and through the contextualization of the analyses results.

The development of the SNA proof-of-concept prototype relies on and extends the services portfolio of the Intelligence Science and Technology Integration Platform (ISTIP). Following service-oriented architecture (SOA) design principles, the ISTIP provides a backbone platform for the iterative and incremental development of software inside DRDC Valcartier Command, Control and Intelligence section. The ISTIP provides loosely coupled, reusable and composable services as foundations to intelligence support systems involved in different research projects. For example, the following features are offered on the platform:

- Automated reasoning of different kind (rule-based, case-based, description logic etc.);
- Anomaly detection;
- Visual analytics;
- SNA;
- Ontology management; and
- Natural language processing.

This section will not describe all the features but rather the ones directly pertaining to the SNA capability.

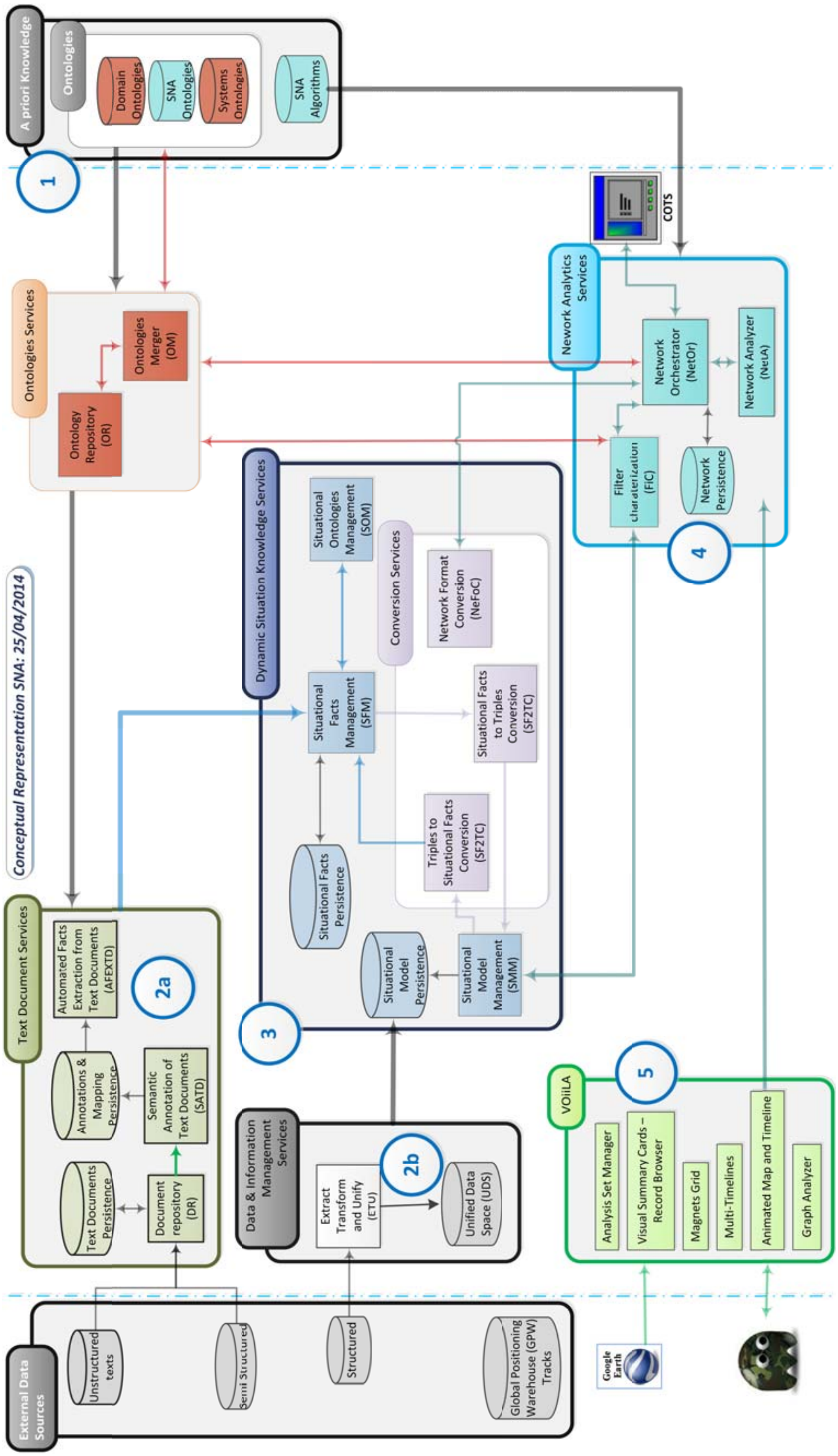

Figure 2 – Software approach for the SNA proof-of-concept prototype

2.1 Data Extraction Services

In order to present visually and analyze social networks, data concerning these networks need to be collected. While a certain amount of this information can be accessed through structured data sources, a significant quantity of information is usually amassed in a multitude of unstructured text reports. The prototype builds this capacity using services based on work done for the Multi-Intelligence Tool Suite (MITS) that had a similar capability [Roy and Auger, 2011]. Depicted in Figure 2 under the point “2a”, these modules extract propositions (facts) in an autonomous manner from unstructured text documents. Since SN data can be expressed in the form of a proposition (fact), the SNA capability leverages the same services for automatic extraction of SN data, which are:

- the Semantic Annotation of Text Documents (SATD); and
- the Automatic Fact Extraction from Text Documents (AFEXTD).

The SATD is a web service that uses ontologies (Figure 2 point “1”) to produce semantic annotations of text documents presented to it. In order to annotate a document, the SATD uses one or more domain ontologies like terrorist ontologies or else SN ontologies. Documents are fed on a continuous basis via a data source crawling service that scans existing databases and returns new documents. Then, given a list of a priory known instances of classes residing within the ontology (classes like people, organizations, or events…), as well as instances of links (links like kinship, affiliation types, etc.), the system annotates the text with these instances. The obtained annotations are subsequently used by the AFEXTD service, which creates propositions (facts) about the SN based on patterns of annotated instances or classes from the text; therefore constructing the social web that ties these social entities together. These patterns are called the text-based templates and they are associated with a proposition template. Each time a text-based template constraint is met inside a document, an associated proposition (fact) is created. Details regarding automated propositions (facts) extraction from unstructured text documents can be found in [Auger, 2009; Martineau and Lecocq, 2013]. In the case of SN entities extraction, these created propositions (facts) have predominantly the underlying format of a triplet (e.g.: subject-predicate-object) and are later stored inside a Neo4j Graph database[1].

At DRDC Valcatier, another research domain focusing on multi-intelligence automatic extraction, storage and organization under a Unified Data Space (UDS) is considering structured data sources pertinent to SNA (point “2b” from Figure 2).

2.2 Data Access Services

The management of the extracted data, unstructured documents and knowledge bases under the form of ontologies is done by the prototype through data access services. This strategy enables efficient data sharing between projects using a unique access point. Also, since the

[1] http://neo4j.org/

extracted data inside triplets are bind to ontologies, a single access point prevents synchronization issues. These services are:

- the Ontology Repository (OR);
- the Document Repository (DR); and
- the Filter Characterisation (FiC).

The two repository services mentioned above are quite straightforward. Like their name say they provide an access to ontologies and documents that reside on the ISTIP platform. They are an interface to a more complex data management system. The data can be accessed by File Transfers Protocol or directly by the file system. However, the services offer an easier access for computer system as well as notification capability when new data come in. Since entities are added and SN components semantic may change over time, ontologies, in which this knowledge is stored, must be obtained through the OR service. This service is used by extraction services (SATD and AFEXTD) to keep the SN up to date and by the filtering service (FiC) to fetch subsets out of it.

The FiC service is used to retrieve SN data from the database. The SNA prototype currently uses a Neo4j NoSQL graph database but it could be replaced by other products or services without impacting the rest of the system. It was found that creation of precise query that could retrieve the appropriate data to answer one's question could be a tedious task. Therefore, selecting and extracting a subset of data from the database is performed through the FiC service. The service simplifies this task by using domain ontologies to create semantic filters that generate precise queries applied to the graph database. For example, an analyst may ask for "kinship relationships" to the FiC service, which in turn exploits the ontology to identify relations like "brother of", "father of", "sister of" or any subclasses of the one of interest. The filtering mechanics is detailed in Lecocq et al. [2013].

2.3 Orchestration and Analysis Services

Performing a complete analysis for an analyst usually requires more than one-step algorithms in order to make sense out of the SN and ultimately, of the situation. In SNA, there are a lot of resources to perform analysis and to make sense out of it. However, they are all uniquely characterized by the technical/semantic aspects of their input and output format. So, to answer a single question that may appear quite simple, the prototype may have to fetch many different networks, use different algorithms in parallel or in sequence and fuse the results. An important portion of the complexity resides in the orchestration of the analyses i.e. selecting the right data, converting it to the appropriate format, calling sub-analyses in a meaningful order, and formatting the output. To handle these tasks, the SNA prototype uses three services:

- the Network Orchestrator (NetOr);
- the Network Analyzer (NetA); and
- the Network Format Conversion (NeFoC).

The NetA service is responsible of carrying analyses on data using many different resources. It is an interface that exposes analyses capabilities from an aggregation of libraries, custom developed analysis and commercial off-the-shelf products. Among those, the “R” language[2] is used for statistical analysis and IGraph[3] is used for network analysis. Like the repository services presented above, it provides a single access point for data analysis that can be called using a single data format. However, the NetA service must be able to call analyses provider using the proper format. To achieve this it relies on the NeFoC services which only purpose is to convert data from one format to the other.

The NetOr is a state-full functionality where one can push data, perform series of analyses and get notifications when they are completed. Its main purpose is to act as a mean to ease all the different stages required to perform analyses of social networks and extract intelligence from them to support sense-making. Within the intelligence community, not all analysts are experts in SNA; such functionality could help them leverage the value of SNA for intelligence purposes. Indeed, from the user perspective, the functionality will result in the need to select a topic of interest to perform the analysis, as well as a domain and some corresponding parameters more specific to the context of the situation of interest (as for instance a time window or a geographic area). Based on these, the NetOr will identify the appropriate algorithms and associated data in order to perform analyses of the social networks. This schema prevents potential misuses where a user attempting to answer a specific question would select inadequate algorithms and data leading him/her to erroneous conclusions without even noticing it.

2.4 Visualisation of the analysis results

Once the analyses performed using the NetOr and NetA services the analyst can visualise the results through different widgets (Figure 2 point “5”) and more specifically the Graph Analyzer widget. Being the core topic of this paper, each of the visualisation widget will be described in the following section.

3 Visualizing to Understand

Since the onset of the SNA research effort, it stood out that visualisation is an essential component of such a capability. Similarly than considering SNA holistically as a capability, the importance of visualisation also goes beyond the sole element of exploring the analyses results [Lavigne et al., 2012]. For instance, visualisation capacity was required in order to explore the relation between the issue being looked up and the related SNA results (point 6 in Figure 1). By the completion of the research investigation of the SNA methods and tools, the research team will have included most of the different components of the SNA capability into specific visualisation widgets or portions of them.

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[2] http://www.r-project.org/

[3] http://igraph.sourceforge.net/

Currently, a series of visualization widgets (Figure 2 point 5) was designed to support analyses of social networks. This series gathers generic widgets (meaning easily adaptable to different domains as for instance the maritime domain) and the Graph Analyzer widget that is entirely dedicated to supporting visualization of SNA results as for instance closeness centrality. The core objective of the visualisation widgets is to develop a high-level understanding of the results produced by the analysis and to externalize this understanding in *explanatory* and *tailored views*. Every generic widget aims to externalize *a view of the world* while the Graph Analyzer focusses on externalizing *a view of the mind*. When the externalization provides a *view of the world*, data and information representing the situation of interest as it stands (or as close as it can be) are made available using different types of lenses permitting the analysis to increase his/her SA. In the case of the Graph Analyzer widget, *a view of the mind* is presented since this view is a result of certain analyses that have been performed and therefore providing an increased level of knowledge about the situation. Internal (or even mental) visualization is a means of instantiating the mental model corresponding to phenomenon understanding, which ones are the results of specific algorithms. The SNA research activities seek to *externalize* that model through a set of capabilities implemented in a *visualization* framework. *Externalize* means making phenomenon understanding *explicit* and *sharable*. In fact, the SNA related widgets and more specifically the Graph Analyzer *package* mental models of understanding in a form that can be *exported*.

First, there is a need to understand visualization as a means to achieve effective human communication (e.g. as quality printing contributes to effective distribution of text). In this context, *interactive visualization*[4] is of great value in order to understand complex phenomena as in the case of analyzing SN. As exposed by Nguyen et al. [2010], "interactive visualization helps the human analyst to gain knowledge of the data through our powerful human visual perception and reasoning skills, ideally driving the system toward more focused and more adequate analytical techniques". Visualization is exploited as a support to an exploration process (generic widgets) and as a vehicle for (explicit) representation (Graph Analyzer). Visualization is considered in several occasions in the current SNA research activities and it must strongly adhere to usability principles that are essential for human – machine synergy. But its two modes call for somewhat different usability emphasis, i.e. the generic widgets promote exploration as a highly dynamic activity (because rapid interactivity is key); and the Graph Analyzer widget relates to higher abstraction levels (e.g. navigating among various knowledge domains, tracking through asserted linkages, new perspectives on the network based on applied SNA measures). Every widget does not work on the *final visualization* of the understanding representation but conducts to its building by the analyst. The objective always remains to provide the analyst with a series of tools and perspectives in order to leverage its expertise rather than attempting to over automate some analytical aspects.

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[4] *Interactive visualization* "is a process made up of a number of interlocking feedback loops that fall into three broad classes. At the lowest level is the *data manipulation loop*, through which objects are selected and moved using the basic skills of eye-hand coordination. […] At an intermediate level is an *exploration and navigation loop*, through which an analyst finds his or her way in a large visual data space. […] At the highest level is a *problem –solving loop* through which the analyst forms hypotheses about the data and refines them through an augmented visualization process. [Ware, 2004]

By definition*,* *visualization* is “the act or process of interpreting in visual terms or of putting into visible form”[5]. *Data visualization* is simply the study of the visual representation of *data*. In other words, a *visualization view* – or *view* or *visualization* – is defined as a graphical representation of concepts or *data*, which is either an internal construct of the mind or an external artifact supporting decision making and/or action. Visualization views may range from simple to complex, but no matter the level of complexity and the type of data, a visualization view is intended to help interpret data in a meaningful way. *Data* can be defined as the raw facts, and doesn’t really have a meaning at all on its own. When data has been processed, data become *information* which has a valuable meaning for human who visualizes it. And *knowledge* corresponds to a transformation of information triggering people to decide and act. The presentation of the relationships among data, information, and knowledge in a hierarchical arrangement has been part of the language of *information science* for many years [Ackoff, 1989][6]. Visualization domain was historically categorized into two major areas: *information visualization* and *scientific visualization*. *Data visualization* is a slightly narrower domain and just an umbrella expression under which the different categories can be gathered. *Information visualization* (visual data analysis) “is the study of (interactive) visual representations of abstract data[7] to reinforce human cognition. […] However, *information visualization* differs from *scientific visualization*: “it’s *infovis* [information visualization] when the spatial representation is chosen, and it’s *scivis* [scientific visualization] when the spatial representation is given” [Munzner, 2008]. *Information visualization* is the most reliant on the cognitive skills of human analysts, and allows the discovery of unstructured actionable insights that are limited only by human imagination and creativity. The analyst does not have to learn any sophisticated methods to be able to interpret the visualizations of the data. *Information visualization* should be considered as a discovery tool enabling the analyst to form a hypothesis about the situation at hand. The SNA prototype should then help the analyst to test such hypothesis through additional analytical of visual analytics functions as for instance the distribution of certain characteristics within a specific network of interest. Scientific visualization as appraised by Friendly [2004], “is primarily concerned with the visualization of 3-D+ phenomena, (architectural, meteorological, medical, biological, etc.), where the emphasis is on realistic renderings of volumes, surfaces, illumination sources, and so forth, perhaps with a dynamic (time) component”. In our context, the purpose of *scientific visualization* is therefore to provide graphics depicting scientific data about a situation. These data should be easily understood by the analysts, create insight and increase their SA.

3.1 Cognitive Overload and Insight

Data overload can be defined as ‘‘a condition where a practitioner, supported by artifacts and other practitioners finds it extremely challenging to focus in on, assemble, and synthesize the significant subset of data for the problem context into a coherent situation assessment, where

[5] http://www.merriam-webster.com/dictionary/visualization

[6] Note that such a perspective has also been many time reconsidered [Murray, 2009].

[7] The abstract data include both numerical and non-numerical data, such as text and geographic information.

the subset is a small portion of a vast data field'' [Patterson et al., 2001]. We can easily agree that dealing with large graphs of SN as well as their relation to other networks can indeed result in data overload. On the other hand, we expect that the insight gained from this analysis is worth the effort. Insight is ''thought to arise when a solver breaks free of unwarranted assumptions, or forms novel, task-related connections between existing concepts or skills'' [Bowden et al., 2005]. A highly promising approach of mixing appropriate computational methods with cleverly designed visualizations is expected to maximize the insight benefits while keeping the cognitive overload at the lowest possible level.

3.2 Visualization Requirements

The general visualization requirements for the intended SNA capability cover all the steps of the analysis process, as exposed in Figure 1, and are ranging from defining the objectives of the analysis all the way down to the SNA products usability [Lecocq et al., 2011]. We further refined the requirements related to the analysis step and mapped them to a taxonomy of visualization methods [Lavigne et al., 2012]. This Visual Thinking Codex [Roam, 2008] is a simple but powerful taxonomy that divides a problem into six slices (the rows of the matrix), in order to depict the problem in the best visual way when thinking or sharing thoughts. The six slices are:

1. **Who and What** problems. Challenges that relate to things, people, and roles;
2. **How much** problems. Challenges that involve measuring and counting;
3. **When** problems. Challenges that relate to scheduling and timing;
4. **Where** problems. Challenges that relate to direction and how things fit together;
5. **How** problems. Challenges that relate to how things influence one another; and
6. **Why** problems**.** Challenges that relate to seeing the big picture.

The Codex is then used to further characterize the problem in order to focus the analysis and the visual information sharing, according to five SQVID questions (the columns of the matrix):

- **S**. Simple or Elaborate;
- **Q**. Quality vs. Quantity;
- **V**. Vision vs. Execution;
- **I**. Individual attributes vs. Comparison; and
- **D**. Delta (or Change) vs. Status quo.

To meet some of the other visualization and analysis requirements related to our SNA research activities, a series of visualization widgets were identified; each widget addresses a slice. Figure 3 shows each slice and the associated widgets. The Graph Analyzer is the most encompassing widget and the center of the SNA visualization capability.

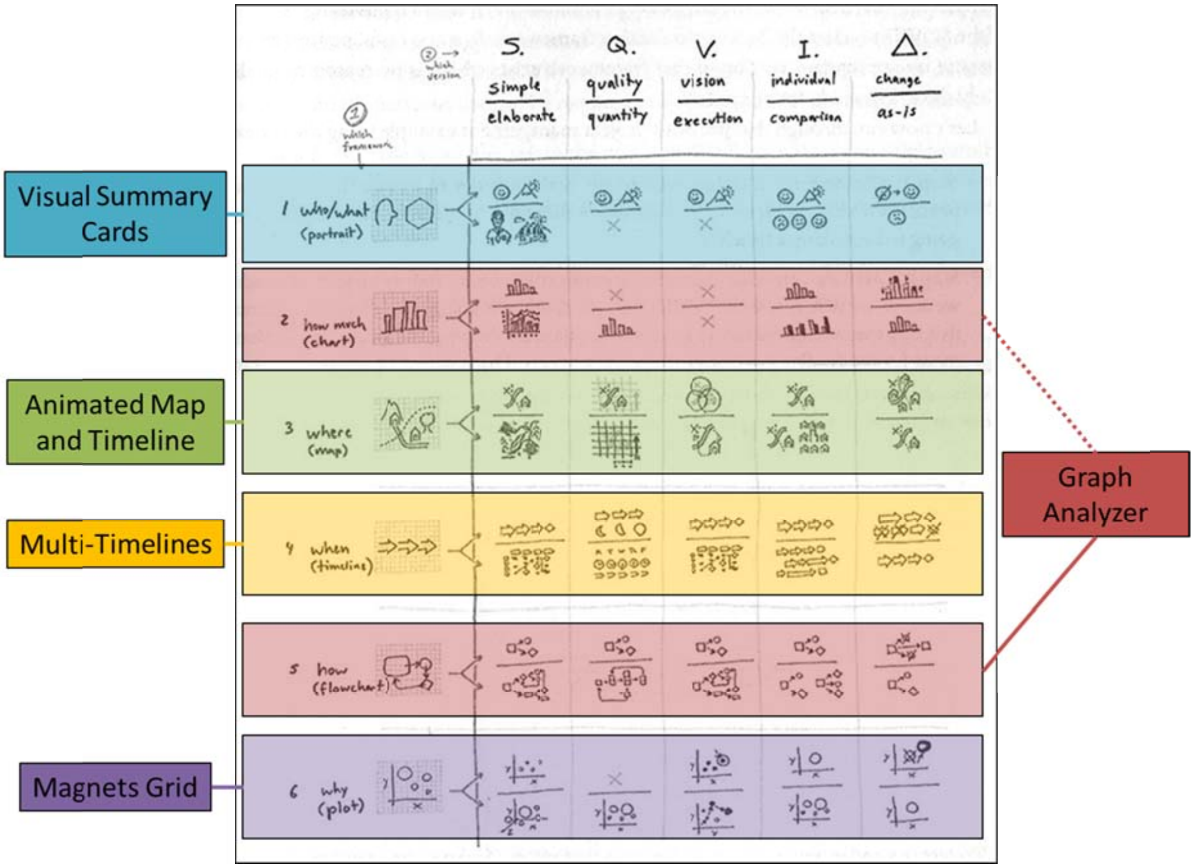
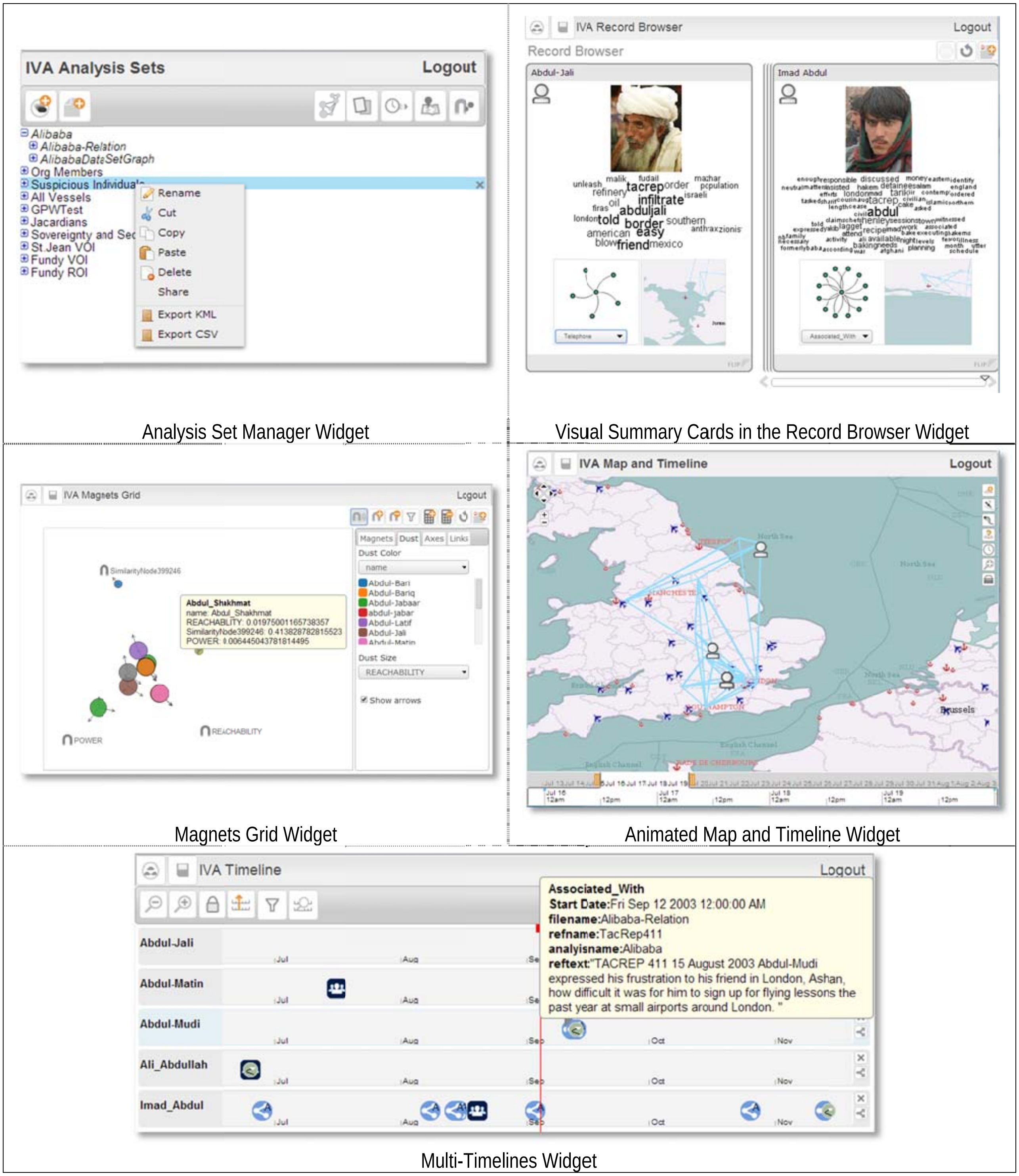


Figure 3 - Visualization widgets in relation to the Roam's Visual Thinking Codex (modified from [Roam, 2008])

3.3 User Interface Description - Adapting Generic Widgets for SNA

As part of our research process, we designed four generic widgets that could enhance analysis for multiple application domains [Lavigne et al., 2011]. We implemented a first version of these widgets in the Maritime Visual Analytics Prototype [Lavigne, 2014]. SNA versions of these widgets were envisaged early in our process [Lavigne et al, 2012]. However, applying these fairly generic tools to a dataset from an entirely different domain required a few adaptations and enhancements to provide a more meaningful visual experience. Figure 4 shows the resulting adapted widgets for SNA.



Analysis Set Manager Widget

Visual Summary Cards in the Record Browser Widget

Magnets Grid Widget

Animated Map and Timeline Widget

Multi-Timelines Widget

Figure 4 - Generic visualization widgets adapted for SNA[8]

[8] The prototype has been tested using an enhanced version of the "Ali Baba" data set initially created in 2003 for the National Security Agency (NSA) by Mark Jaworowski and Steve Pavlak [Jaworowski, 2003]. This version of the dataset has been enhanced by the Army Research Laboratory as well as, later on, by DRDC with additional data required to enable some of the SNA use-cases.

3.3.1 Analysis Set Manager

The Analysis Set Manager serves as the visual repository for the analyzed data and is the starting point of the visualization capability. This widget groups information elements together into “analysis sets” displayed in a hierarchical structure. Any set can then be selected and sent to another visualization widget for further analysis. Based on manipulation of the sets performed in other widgets, new data sets can be created. These refined data sets can be defined following the intelligent analyst’s needs helping him to progress with respect to pending intelligence gaps. In the specific case of SNA, sets are comprised of networks nodes and links along with computed social metrics data.

3.3.2 Visual Summary Cards and Record Browser

The Visual Summary Cards are meant to display all the relevant characteristics of an entity visually using images and icons to represent the information, so that they can be parsed very quickly. The Record Browser lets the user flip those cards rapidly. The user can also drag a card to the left part of the widget for rapid visual comparison between cards. The backside of the cards contains all the relevant textual details for deeper analysis. Although the concept is generic, this widget requires a careful design of the cards content that must be tailored to each application domain. For the SNA prototype, the cards depict nodes of the SN (persons, organizations or groups). Information related to the node identity and characteristics are included such as the name, nationality, known allegiance, last report where the individual was mentioned. Other data of the card provide network related metrics, a snapshot of their ego network and a geographical display of their associated current and past locations. The ego network can be dynamically changed to reflect the types of links the individual is involved in.

3.3.3 Magnets Grid

The Magnets Grid allows the simultaneous exploration of multiple dimensions of information. Any characteristic of the set entities can be placed on the canvas as a magnet. The nodes forming the set are depicted as “dust” dots that react to the magnets present. When the shake button is pressed, the dots move towards the magnets at a speed proportional to the attribute attraction strength. The nodes attributes can also be associated to the node size or color. They can even be selected as axes, creating rows and/or columns that constrain the dust movements. This is one of the easiest widget to adapt for reuse since the attributes and characteristics are automatically provided in the widget based on the data set. The SNA prototype made a direct reuse of this widget for its own benefits. The calculated network measures can be used as a characteristic attracting the nodes, which are the dots.

3.3.4 Multi-Timelines

The Multi-Timelines display temporal events related to entities on separate rows. The timelines can be desynchronized, allowing the visual comparison of events that happened during different time periods. The timeline related to a particular entity can be duplicated on other rows, allowing self-comparison to detect patterns related to previous occurrences. This widget displays the temporal events associated with the selected network nodes. For the SNA

prototype, events can be anything with a timestamp as for instance meetings, communications, or else reports where the node was mentioned. Using the mouse over more details is provided with respect to the event.

3.3.5 Animated Map and Timeline

With the Animated Map and Timeline, one can select a geographical area and a time period for the display. Dragging the selected time period along the timeline area below the map produces a smooth animation of the entities displayed on the map. This widget can support the Graph Analyzer by showing how the geographical locations associated with node change in time. When desired, only some specific nodes and their tracks can be selected and highlighted in order to provide a more accurate time display to the end-user.

3.4 Graph Analyzer Widget

Unlike the four widgets from the left part of Figure 3, the Graph Analyzer widget is entirely dedicated to SNA. This widget exhibits nodes/entities (e.g. persons or groups) and (directional) links/relations (e.g. affiliation type and influential type). In terms of representation, it is inspired from the focus node technique involving that the rest of the nodes are presented around it. The node of interest can be re-position upon the analyst instigation, in that case, it will move toward the left upper side of the display having the related nodes organized based on the depth of their connection to it. Existing link types are analyzed and a legend is created/displayed allowing users to filter specific relations under the “Links” tab. The Graph Analyzer widget has also to support analyses leading to identify social similarity, complicity, allegiances between nodes/entities as well as how these nodes topologically behave with respect to the network. Therefore, supplementary analysis results, under the “Analysis” tab, are inserted in the display at will. These results based on the SNA are displayed using dotted lines in the widget. Figure 5 shows for the two first layouts, a display of the network relations from the “Links” tab, followed by one layout displaying calculated SNA measures under the “Analysis” tab.

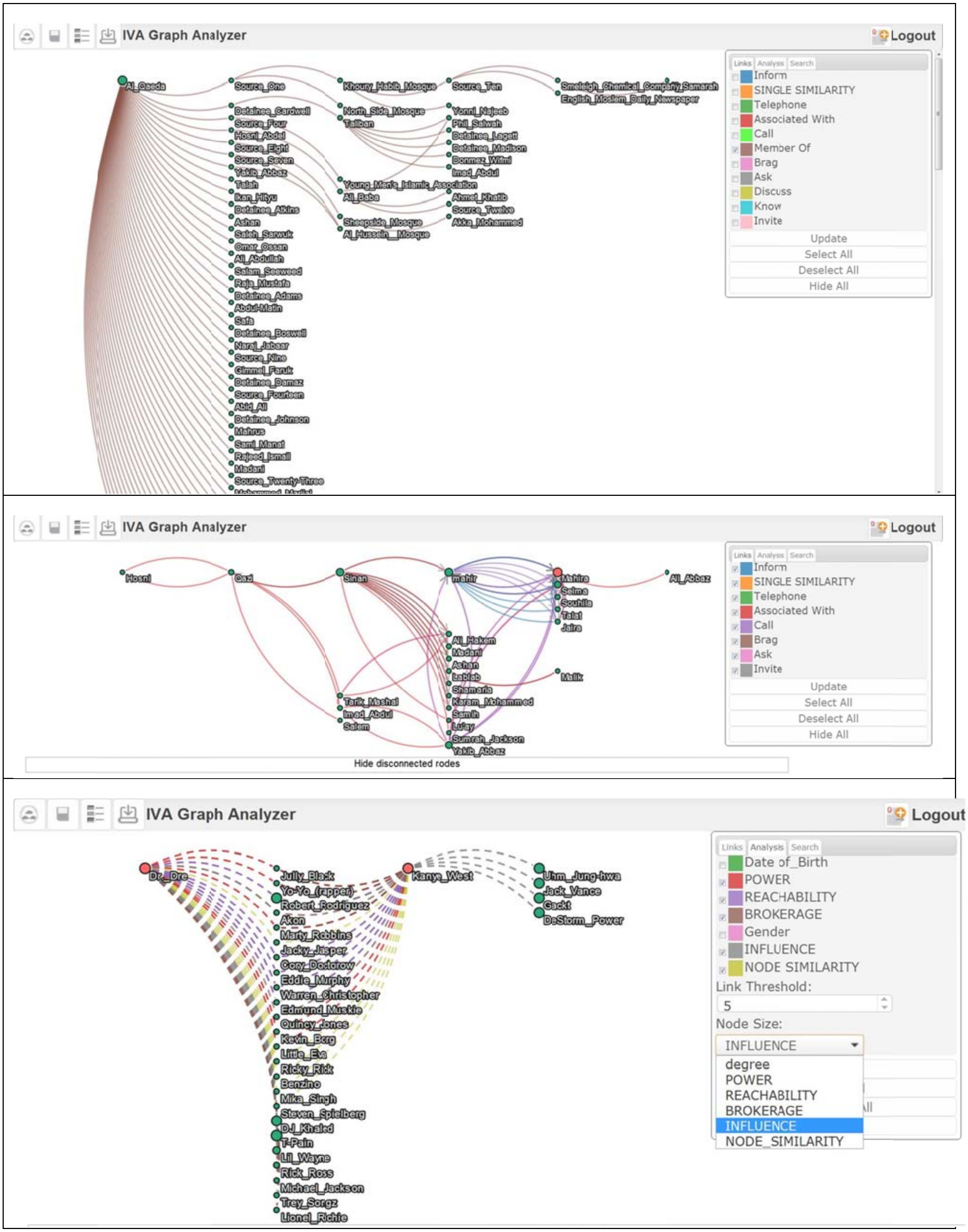


Figure 5 - Graph Analyzer widget: first version

4 Conclusion and Future Researches

During the last few years, DRDC has investigated SNA methods and techniques by means of a proof-of-concept prototype development. The first year was dedicated to activities meant to understand the military requirements for SNA methods and tools as well as to analyse currently available ones on the market. The output emphasized the following need among others:

- a SNA capability, as exposed previously, rather than an analysis tool solely;
- a SNA capability that is considered to be one of the several analyses required to be performed by the analyst for a specific issue;
- methods and techniques that are generic and applicable to other contexts than COIN; and
- tools that are easy to use and to understand even by individuals who are experts in their domain but not necessarily with respect to SNA per se.

Based on the above, the SNA proof-of-concept prototype first intended to develop the generic SNA supporting services in accordance to SOA principles. This permitted to develop a network analysis prototype rather than a specific "SOCIAL" network analysis capability. In the future, the same services could be used to analyse other networks like cyber networks for instance. Very rapidly, the project started to leverage visualization and visual analytics techniques to carry the value of the social networks analyses results to the intelligence analyst.

In the context of SNA, much remain to be performed in this area. Indeed, only some of the visualisation requirements identified in Lecocq et al. [2011] were actually instantiated at this point, as for instance the link views requirement.

The coming research activities will focus on instantiating the remaining requirements, running the use-cases with real data and modifying the prototype based on the results, adapting more closely the visual analytic components to the military context, investigating real value of immersive visualization environment in the context of SNA, transposing the proof-of-concept prototype to different network analysis contexts, integrating some of our reasoning services to enhance the analysis results.

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